EDITION B

The Journal of the INSTITUTION OF PRODUCTION ENGINEERS

Vol. XXI No. 8

AUGUST, 1942

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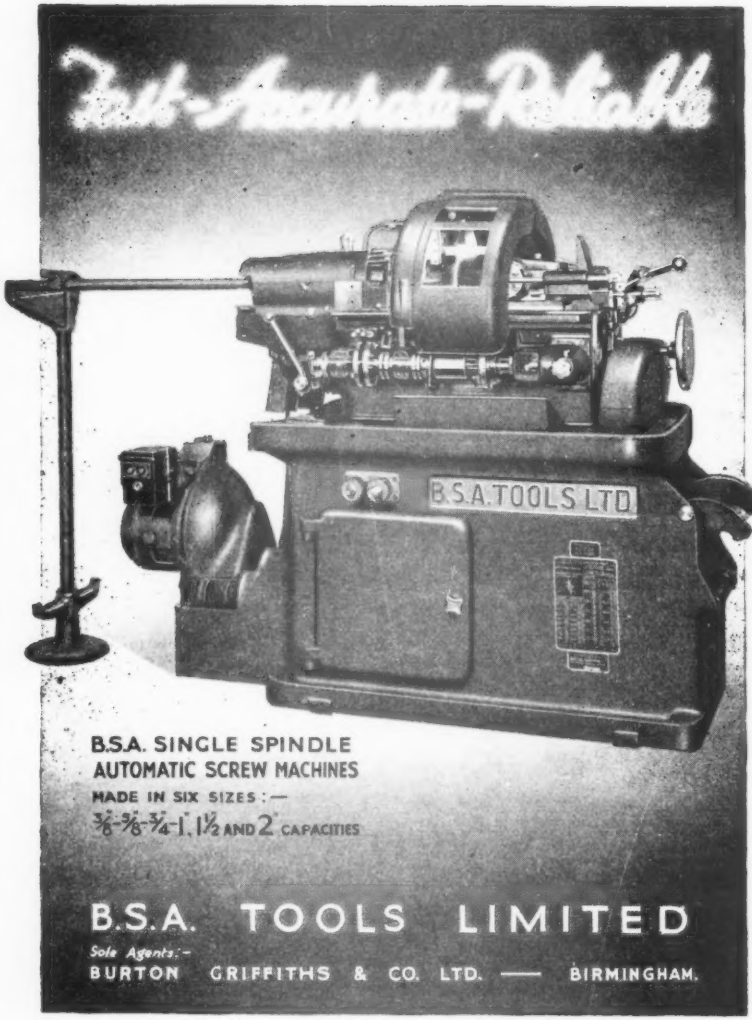
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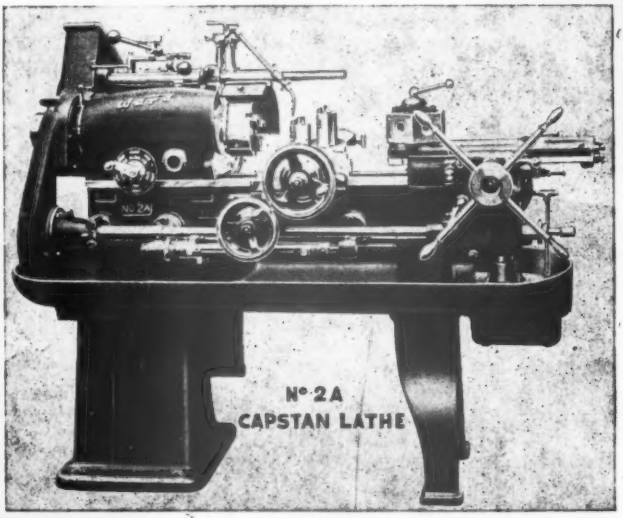

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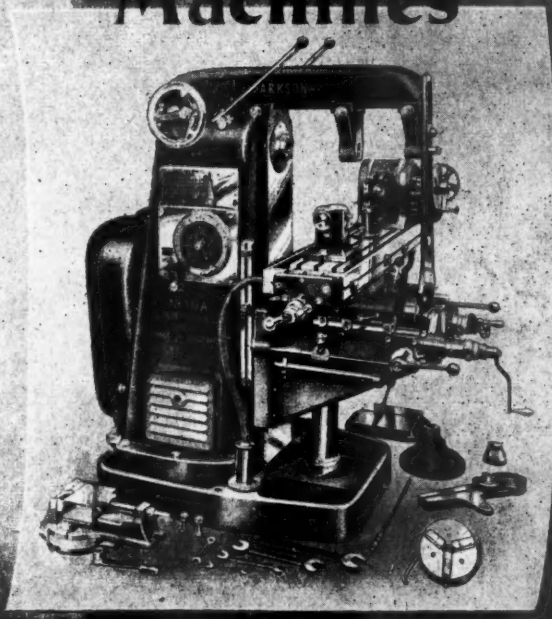

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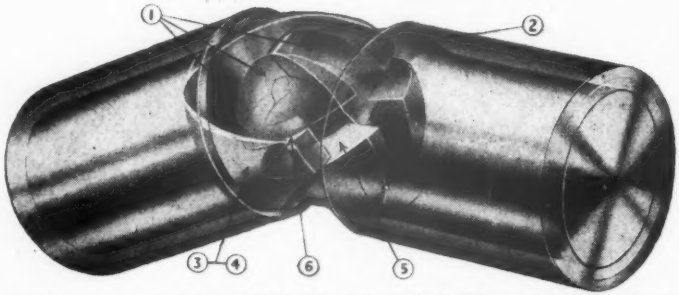

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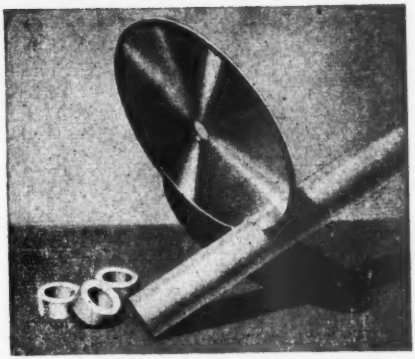

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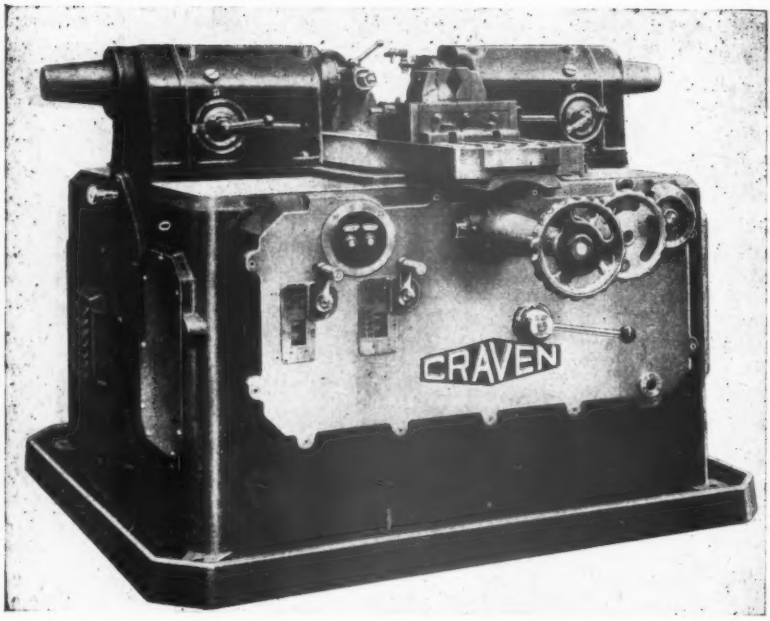

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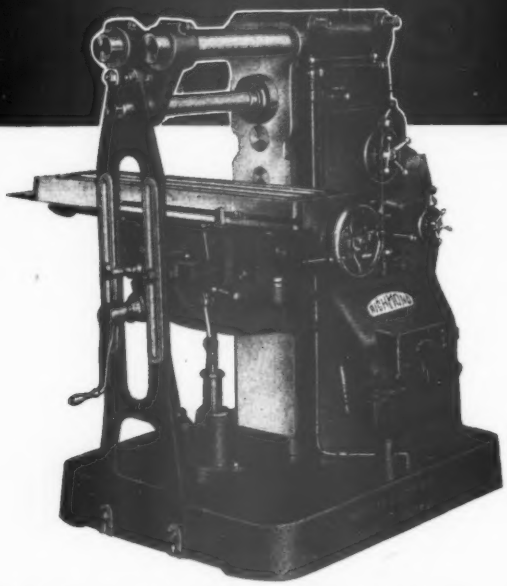

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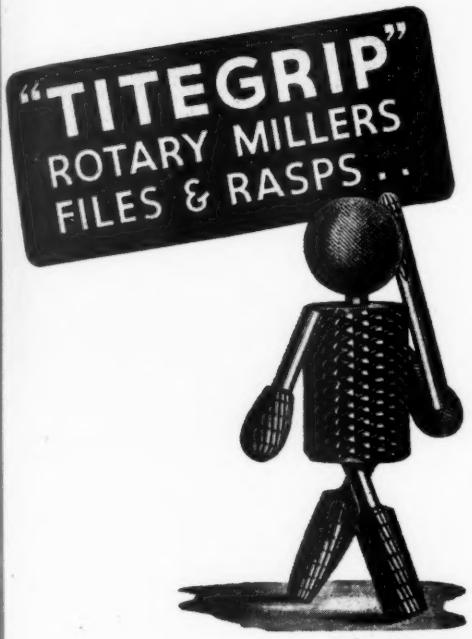

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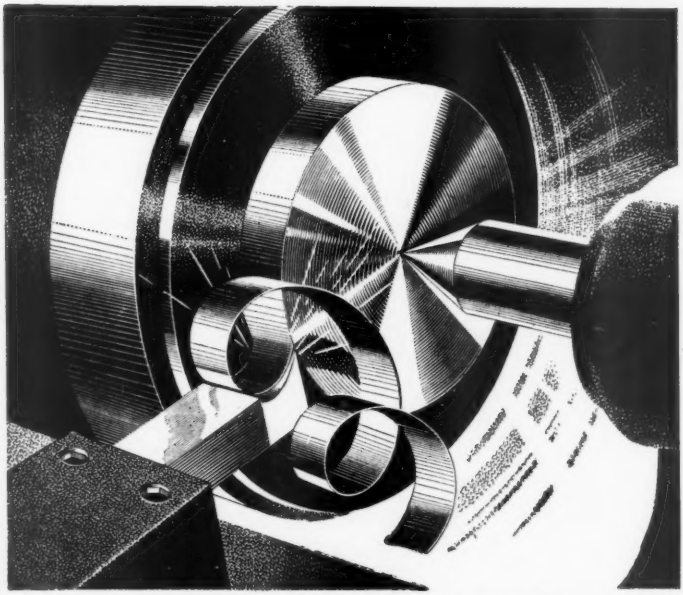

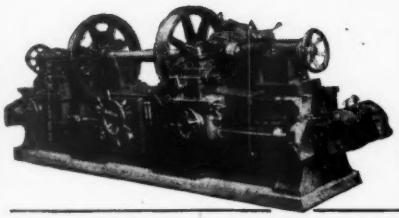

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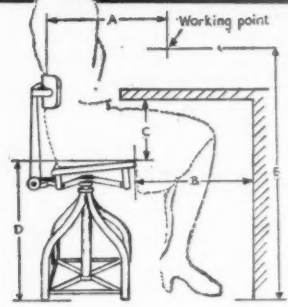

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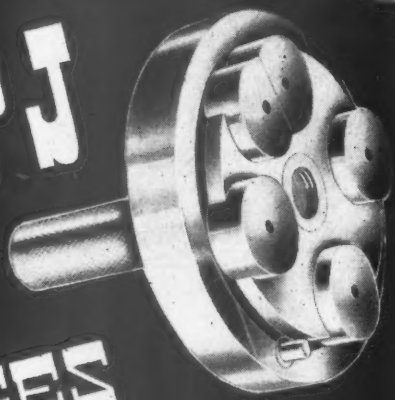

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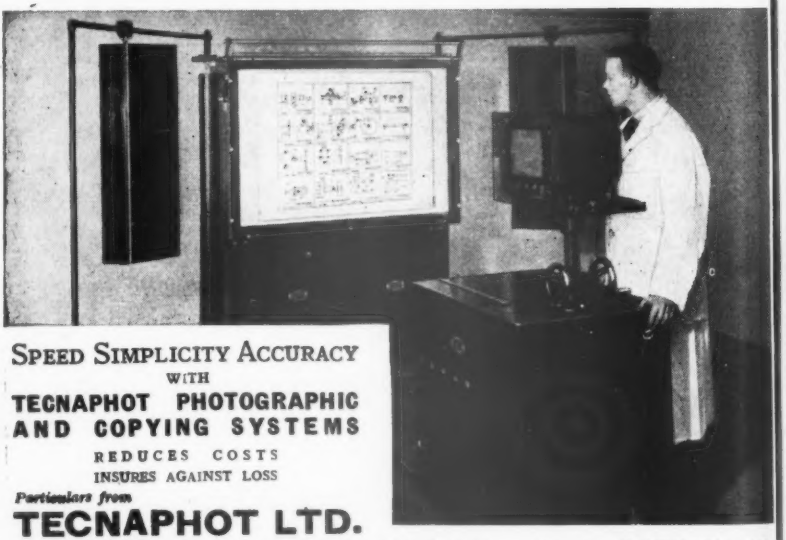

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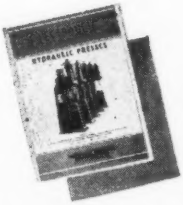

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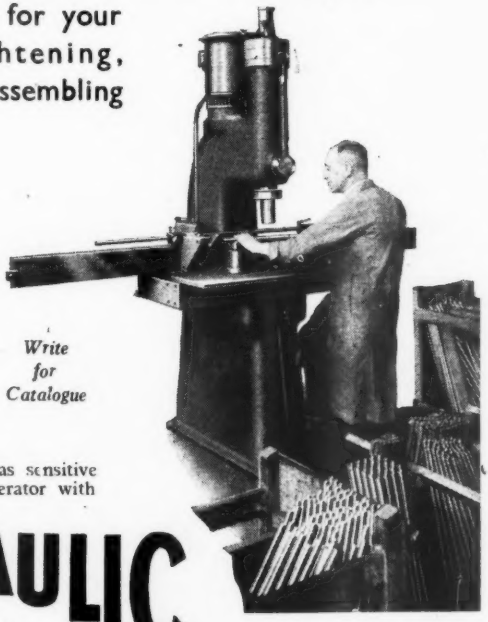

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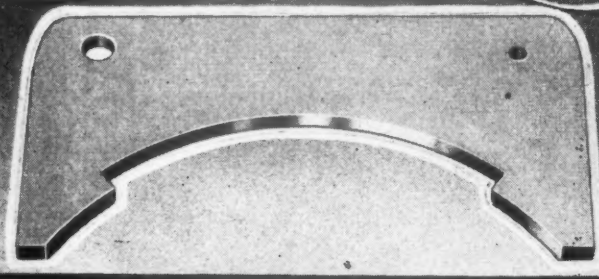

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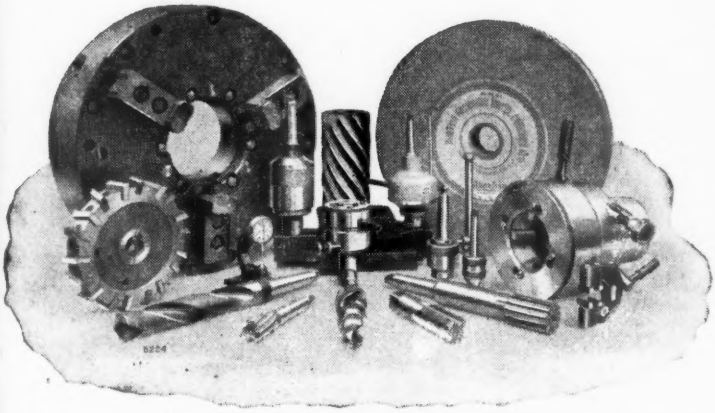

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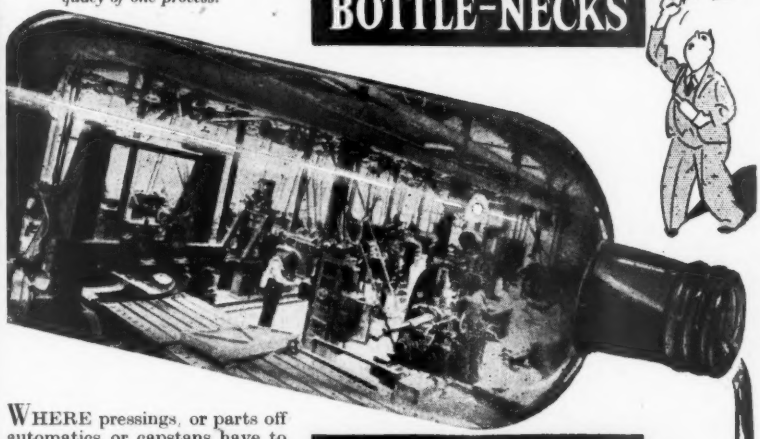
The bugbear of modern production is the "Bottle-neck," the point where the flow of work is held up by the inadequacy of one process.

FOR BREAKING "BOTTLE-NECKS"



ON YOUR MASS-PRODUCTION LINES

WHERE pressings, or parts off automatics or capstans have to be cleaned or degreased (between processes or before inspection or lacquering,) hand cleaning is unsatisfactory and creates an unnecessary bottle-neck. This bottle neck can be eliminated by installing a DAWSON CLEANING AND DEGREASING MACHINE which will carry out the work of twenty hand cleaners. Designed either for large quantities of small parts or for cleaning and degreasing large and cumbersome or intricate parts, it can be incorporated into conveyor systems and timed to maintain the mass-production flow of work. Five standard types; three for washing and degreasing; one for washing, degreasing, and rinsing; and one for washing, degreasing, rinsing and drying. Adaptations can be made for special work. The labour and cost saved and the increase in output effected will soon cover the installation expense. Full details on application.

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METAL PARTS CLEANING AND DEGREASING MACHINES

INDEX TO ADVERTISEMENTS

As a war-time measure the advertisement section of this Journal is now published in two editions, A and B. Advertisers' announcements only appear in one edition each month, advertisements in edition A alternating with those in edition B the following month. This Index gives the page number and edition in which the advertisements appear for the current month.

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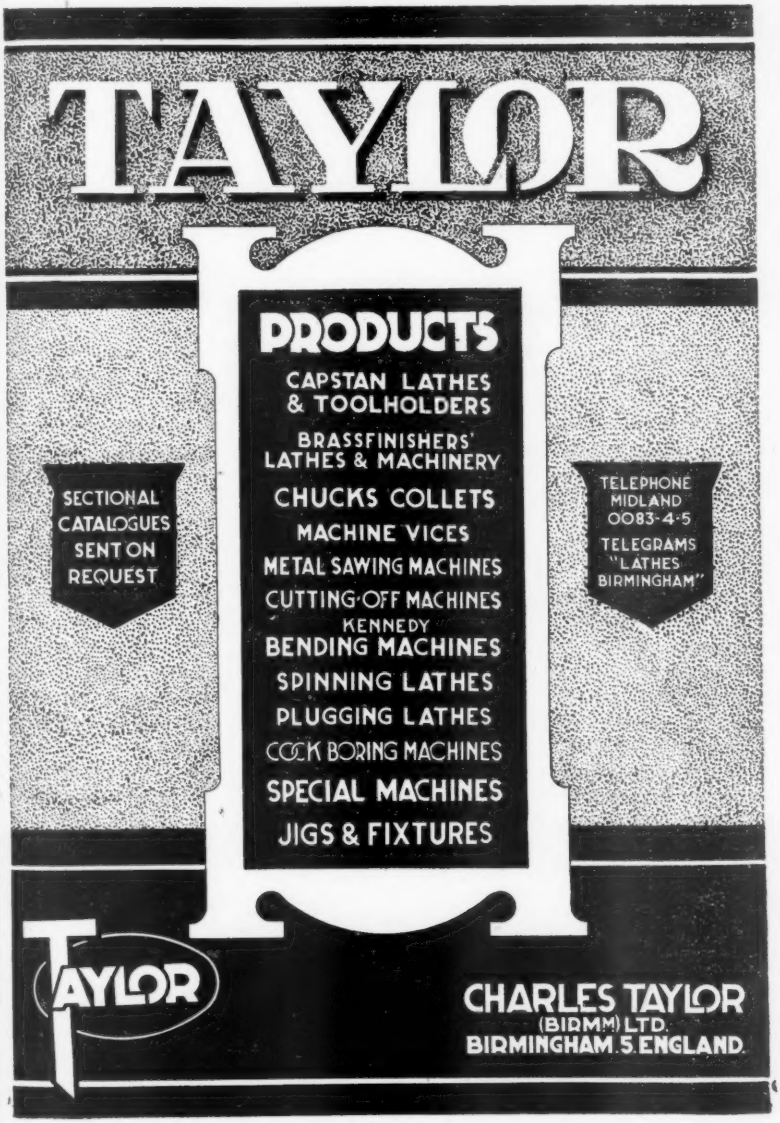
Craven Bros. (Manchester) Ltd.	x B
Dawson Bros. Ltd.	xxvii B
Desoutter Bros. Ltd.	xiii A
Drummond (Sales) Ltd.	xxiii B
Fenner, J. H. & Co. Ltd.	xxvii A
Firth, Thos. & John Brown, Ltd.	xvi A
Gilman F. (B.S.T.) Ltd.	xiii B
Herbert, Alfred, Ltd.	xi A xxv B
Higgs Motors, Ltd.	xxv A
High Duty Alloys, Ltd.	xix B
Holman Bros. Ltd.	xxxii B
Jackman, Geo. Machine Tool Co. Ltd.	xxvi B
Jessop, William, & Sons, Ltd.	ii A
Jones, E. H., Ltd.	xvi B
Leabank Chains Ltd.	xx B
Leytonstone Jig and Tool Co. Ltd.	ix A
Lund, John Ltd.	xx
Macrome, Ltd.	xxvi B
Midgley & Sutcliffe	xii B
Midland Saw and Tool Co. Ltd., The	iii A
Mollart Engineering Co. Ltd.	viii B
Motor Gear Engineering Co. Ltd.	xxiv A
M.P.J. Gauge and Tool Co. Ltd.	xx B
National Alloys, Ltd.	vii B
Newall, A. P., Ltd.	xxxii A
Newall Engineering Co. Ltd.	xxx B
Norton Grinding Wheel Co. Ltd.	v A
Optrex, Ltd.	xxii B
Parkinson, J., & Son	v B
Pryor, Edward, & Son, Ltd.	xxiv B
Reavell & Co. Ltd.	vi A
Sanderson Bros. & Newbould Ltd.	xviii B
Snow & Co. Ltd.	xix A
Stedall Machine Tool Co. Ltd.	xvii A
Taylor, Charles, Ltd.	xxix B
Taylor, Taylor & Hobson, Ltd.	xiv A
Tecnaphot, Ltd.	xxii B
Timbrell & Wright Machine Tool Engineering Co. Ltd.	viii A
Urquhart, Lindsay & Robertson (Orchar), Ltd.	xv B
Voucher Ltd.	xviii B
Ward, H. W., & Co. Ltd.	iv B
Ward, Thos. W., Ltd.	iv A
Wearden & Guylee, Ltd.	xxxi B
Wickman, A. C., Ltd.	vii A ix B
Wolverhampton Die Casting Co.	xxxi A
Woodhouse & Mitchell Ltd.	xxii A

The fact that goods made of raw materials in short supply owing to war conditions are advertised in "The Journal" should not be taken as an indication that they are necessarily available for export.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BRASSFINISHERS' LATHES & MACHINERY
CHUCKS COLLETS
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KENNEDY
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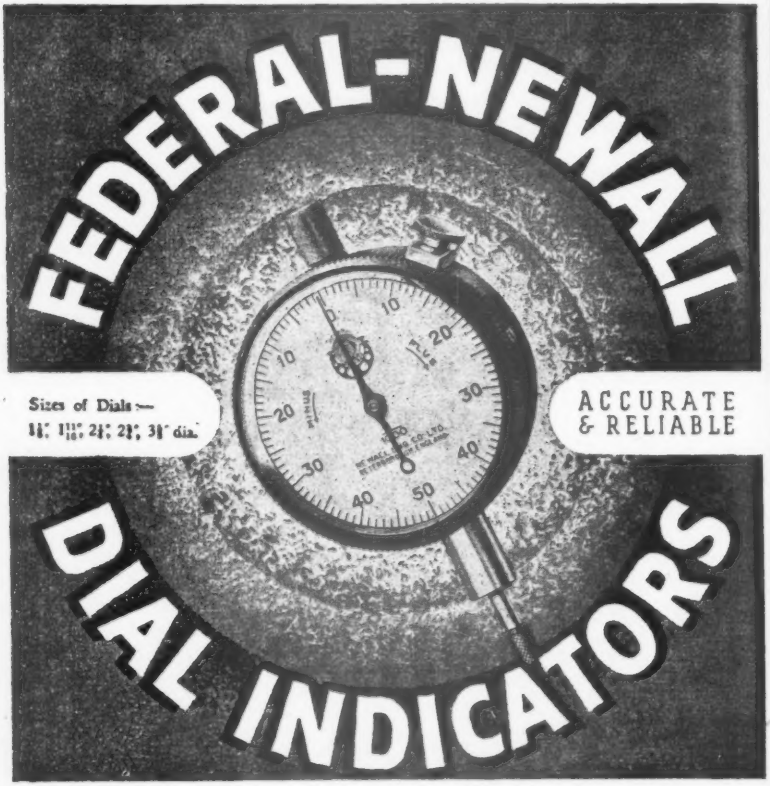

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INSTITUTION NOTES

August, 1942

Fixtures.

Sunday, September 6—Luton Section. Paper by Mr. F. H. Bates, A.M.I.P.E., on "Tungsten Carbide Cutting Tools," the George Hotel, Luton, 10 a.m.

Research Department: Latest Developments.

The Standing Committee on Research met in London on August 13, when it considered and adopted, subject to some modifications, a joint report from the Executive and Finance Committees of the Research Department putting forward a comprehensive plan for the future wark of the Department. The revised report is to be submitted to the Council of the Institution and, later, to a general meeting of supporters, including Affiliated Firms.

The income of the Research Department for the financial year ended June 30, 1942, was between £6,000 and £7,000, compared with £2,805 for the previous financial year. The new Research plan when fully in operation is estimated to cost £19,400 annually. As finally approved the Plan will be published in *The Journal* and be made available also in pamphlet form.

It is hoped that, when published, the Plan will receive the careful attention of members and that they will do all in their power to secure for it the support of their firms.

Before a Plan of the kind could be put forward with any confidence of success, the Research Committee had to be in a position to show that it is based on practical experience of what could be done and to point to valuable work already accomplished.

The outstanding work of the Department to date is the research on Surface Finish, the report on which was published in March of this year. That report received immediate recognition ir this country, where the British Standards Institution, at our request, at once took steps to prepare a British Standard for the Measurement of Surface Finish, based on the report. The British Standard will be issued shortly.

Recognition of the value of the work has been equally prompt in the United States of America. The American Society of Mechanical Engineers informed us that it was much impressed by the report, and a proposal from it to publish the report in the United States, on behalf of our Institution, has been accepted. In addition,

it published in the July issue of *Mechanical Engineering* a review of the report, four columns long, by Mr. Stewart Way (Research Laboratories, Westinghouse Electric and Manufacturing Co.) The following are a few extracts from the review :

> " Ever since the appearance of the preliminary report of the Institution of Production Engineers on Surface Finish, in *Engineering*, March 29, 1940, a great many production men and research workers in this country have been looking forward to the publication of the complete report.
>
> " Dr. Schlesinger's book is particularly welcome because it is one of the few books in the English Language on the timely subject of surface finish and because it brings together much new and hitherto unpublished information . . . Much progress has been made in producing and measuring metal surface finishes. No small part of this progress has come about through the work of Dr. Schlesinger and his co-workers."

Personal Notes.

His Majesty the King has approved the award conferred on Major Percy R. Clark (*Member*), by the King of Greece, of the Greek Distinguished Service Order.

Mr. R. Appleby (*Associate*), has been appointed Head of the Production Control Branch for the Regional Division, Ministry of Production.

Mr. P. H. Lee has relinquished the Hon. Secretaryship of our Edinburgh Section, due to taking up a position away from Edinburgh.

Mr. A. A. J. Francis (*Associate Member*), and Mr. W. E. Washbrook (*Member*), have been appointed to represent the Institution on the British Standards Committee dealing with Collets for Machine Tools.

Birmingham Section Activities.

The Birmingham Section has recently held two crowded and successful lecture meetings. At the meeting on July 16, the speakers included Colonel H. B. Sankey, Regional Controller, Ministry of Production, and Mr. Walter Higgs, M. P. At the meeting on August 19, the speaker was Mr. R. Appleby (*Associate*), who gave an address on Production Control.

THE MEANING OF PRODUCTION CONTROL

By R. Appleby (Associate)

AT a meeting of the Institution of Production Engineers held at Storey's Gate, Westminster, on January 31, "Production Control" as the subject under discussion disclosed differences of opinion between speakers as to the precise meaning of the term, and it was generally agreed that before the request for detailed discussion could proceed, agreement on the content of Production Control would be a first essential.

As a result, the Committee set up by the Institution to deal with the subject devoted considerable attention to this issue.

Certain definitions were adopted which are quoted in the chart included as an appendix by permission of the Committee. This paper is an attempt to show the principles which form the basis of these definitions.

The Committee divided its approach to Production Control under five headings as follows—

1. Analysis of the Term "Production Control."

- (a) Production—General Definition.
- (b) Production—Industrial Definition.
- (c) Production—Interpretation Adopted.
- (d) Control—Historical Basis.
- (e) Control—Evolution of Technique.
- (f) Production Control.

2. The Conditions That Must Be Satisfied By Production Control.

- (a) Necessity for Premeditated Control Must Lead to Planning.
- (b) Necessity for Accurate Forecast Based on Past Experience.
- (c) Necessity for Collection and Distribution of Information.
- (d) Specific Conditions.

3. Machinery of Production Control.

- (a) Relatedness of Functions Which Are Not Purely Production Control.
- (b) Purely Production Control Functions.
- (c) Is Planning "Production Control?"

4. Scope and Future of Production Control.

(a) Production Control has Its Roots in Necessity.
(b) Growth of Production Control Inevitable.
(c) Necessity for Evidence.
(d) Historical Factors.
(e) Significance of Industrial Organisation in the Past Ten Years.
(f) Irrelevance of Political Motives.
(g) Production Control Essential for Maximum Productivity in War-Time.
(h) Maximum Productivity Essential in Peace-Time.

5. Who Is the Man for Production Control.

(a) Divisions of Responsibility.
(b) Ability for Organisation the Primary Factor, Engineering Secondary.
(c) Predominance of Engineering Qualifications.
(d) Necessity for Training Executives to Provide Ideal Combination.
(e) Present Limited Choice.

1. Analysis of the Term "Production Control."

It is necessary that Production Control should be examined from both the Production and the Control standpoints and having satisfied the enquiry which a separate analysis will give, examine the term in its joint meaning.

(a) PRODUCTION—GENERAL.

Production can mean many things, from the conception of production by the economist and the conception of production by the production engineer. The economist considers that any work or function directly related or auxilliary to the production of any commodity or service is a part of the productive function. Production without distribution in modern society would be of no purpose, and is, therefore a part of the productive function. In a narrow sense, also distribution cannot be divorced from production in the transport of manufactures from machine to machine, etc.

In the same way, development and design are as closely related to production and both are indispensible. Further, in that they are entirely directed towards increasing the utility of goods and service for the benefit of the community they can also be classified as production.

We speak of the production of foodstuffs and it could reasonably be argued that if there is to be any sub-division of the entire

function of Production, food production is the most important of all.

There are other forms such as coal and petroleum or any other raw material production, in fact any act or effort expended by individuals with the ultimate aim of producing goods for their own consumption or use, falls within this category. This is the economists definition of production.

If this was the definition of production with which we are concerned, it would mean that we should be examining the control of everything and there would be no limit to the field of survey for the persons concerned with Production Control. But when we so loosely speak of production we do not mean to convey this impression for we are not concerned with production in so general a sense.

It is therefore necessary to define the Industrialist's conception of production which is tenable for the purpose of expressing Production Control.

(b) PRODUCTION—INDUSTRIAL.

Do we consider the industrialist or industrial concern to be one engaged in manufacturing process on raw materials or semi-finished and finished goods? Generally this definition holds good, but even with this limitation the difficulty has to be faced that as industry grows, its tendency is to embrace more and more of the sevices which it is dependent upon to set it in motion, keep it running, and distribute its products. There is no clear line of demarcation of the processes embraced by the industrial undertaking.

Not only is there no clear line of demarcation but there is also so much diversity of product as between one unit and another that problems so divergent as the production of rolling mills compared with large assembly plants present themselves to the person trying to define what production his conception of Production Control is concerned with. In one, the control of machines and processes is of primary importance, and in the other, the emphasis of control must be on labour.

The further we attempt to define production, the greater the difficulties become and it must be admitted that whatever definition is placed upon the term it will be impossible to be specific in all cases without qualification. Moreover, it must be borne in mind that even with the most limited use of the word, it must have a wide meaning and that the various phases of Production will have to be considered under separate headings in relation to the control thereof.

(c) PRODUCTION—INTERPRETATION ADOPTED.

Taking account of all the foregoing the interpretation of production here adopted is limited to direct manufacturing processing applicable to the various branches of Engineering.

(d) CONTROL—HISTORICAL BASIS.

If we consider any act of production, no matter how simple, we shall find that there must always be an element or degree of control even though the control may not be conscious. By using the example of a man driving a nail into a piece of wood, it is necessary for him to control the hammer. The greater the *degree* of control he exercises over the hanmer, the more efficiently will he use his capacity to drive home the nail.

This applies to everything we do, but as the processes of production become less dependent upon individual effort the close and often subconscious connection between control and production becomes less apparent, until in the more complex forms of production to-day, the control of the individual and its relation to the the act of production becomes ever more difficult to trace. In effect, the greater complexity of production processes automatically introduces a degree of control by more than one individual and it can no longer be subconscious or automatic control. It must be premeditated in order for the individuals to be co-ordinated in the many acts of production over which they must excercise control. It does not matter that each individual may be able to control his portion of the production process by subconscious control, what does matter is that these individuals *must* be co-ordinated by conscious control.

Control, is nothing new, even though we may be giving more attention to it today than hitherto. In all factories, no matter how inefficient, no matter if they have never heard of the term "Production control," production is controlled.

(e) CONTROL—EVOLUTION OF TECHNIQUE.

But if this is so, why so much controversy about something which by the very nature of things must be? After the industrial revolution which brought with it the factory system and ultimately the industrial organisation with which we are all familiar, many economists, attempted to define the components which provided the basis of an industrial economy, and these they expressed as factors of production. The early economists considered that there were three factors of production, namely, Capital, Land and Labour. Later, however, the question arose of a fourth factor of production, but this was not clearly defined until the 1880's, when Marshall said that the fourth factor of production was *Organisation*.

His theories, which were obviously a reflection of the growing necessity for organisation which inevitably followed industrial development, have since been examined and improved, and organisation is now recognised as a production factor by economists and industrialists alike.

At first, however, organisation dealt with the larger and more general problems which a growing technology and complexity of product demanded, but eventually it became more specialised and ultimately gave rise to the science of management. Production Control is a part of the science of management and the reason that we are so much concerned about it today is because the complexity of production has forced upon us an ever increasing necessity for a greater degree of pre-meditated control.

The word, Control, does not, however, express what is in the mind for we have seen that control must at all times rest with individuals no matter how remote those individuals may be from the act of production and the control we are considering today is more a *means* by which individuals can exercise control rather than a method which removes it from them. The control we are speaking about, and trying to get our ideas clear on, is not control in itself, but rather the medium through which control finds expression.

When an instruction is given by someone who is exercising control by co-ordinating other individuals, he can give his instructions verbally. In that case the voice would be the medium by which control is expressed. Today individuals cannot exercise control by verbal methods because the vast amount of information which must be available to enable production to proceed could not possibly be conveyed in this manner. The medium has, therefore to change to written instructions and information. Even this, however, has now become so voluminous that their issuance and co-ordination, their timing and authority, have in themselves become a speciality.

The control we speak of so vaguely is, therefore, the machinery of co-ordination.

(f) PRODUCTION CONTROL.

Production Control is, therefore, that part of management science which is concerned with the correct degree and medium by which control can be exercised in the co-ordination of the productive resources available in an industrial undertaking.

2. The Conditions That Must Be Satisfied By Production Control

We must define what conditions must be satisfied by Production Control if it is to provide for the correct degree of control expression, and attempt to assess what advantages it possesses over the method of Production Control which it replaced.

(a) NECESSITY FOR PREMEDITATED CONTROL MUST LEAD TO PLANNING.

No method of production today is so simple that entire control can be exercised by the personal method; certain information

must be put on to paper. The simplest forms of production existing are usually those which enable engineering drawings and layouts to be turned into material and parts by a person giving verbal instructions relating to quantity, time of productive delivery, etc. This is the general case in which control is personal, i.e. in the translation of engineering information in the form of drawings, etc. into production. Consequently, the first requirement of Production Control is that it should be able to translate engineering information into parts and assemblies in the most suitable manner. It is obvious that just as a drawing prepared by a draughtsman is better than a scrap of paper with a sketch on it, the properly prepared instruction accompanying the drawing, giving authority for certain quantities to be produced, is better than verbal instructions. At a certain point personal control is bound to break down for the method is incapable of dealing with more than a very few factors of this nature.

It has been said that Production Control is premeditated control. In other words, there is very little difference between issuing information by verbal or written means if that information is to be released haphazardly and without regard to a number of other considerations. The only advantage of written information in this case would be that the information is made available irrespective of whether any one operates to it or not.

Information which cannot be carried out is, however, nothing more than so much writing and Production Control information must be issued in accordance with known conditions of capacity and requirements against that capacity, if it is to succeed as the co-ordinating medium aimed at achieving the maximum output from productive resources

It follows that Production Control must be based on a predetermined plan of production which has taken account of the capacity of the production unit. It must then be able to set the production capacities in motion according to the plan which has also been based on engineering and other information.

(b) Necessity for Accurate Forecasts Based on Past Experience.

To enable this to be done, Production Control—amongst other things—uses the information of what has taken place in the past in order correctly to forecast what is likely to happen in the future under similar conditions. Conditions are of course, never constant and it is inevitable that the forecast on which the plan is based will be subject to variations. Until the effect of these variations can be reflected in the plan of production, of which they are a part, the plan will not be achieved and the affect on oncoming planned production will not be taken into account, so that a large number of unknown factors will cause Production Control to fail.

This means that Production Control must be so organised that it provides for adjustments to the production plans of the present and future according to the physical variations which are continually taking place. In other words, one aspect of Production Control is that it must reflect the physical movement of labour, material and machines. *The importance of this clerical reflection of physical movement cannot be overstated because of the fact that the greater the number of variations, the more difficult it becomes to deal with them, whilst their importance could be said to increase as the square of their numerical frequency.*

(c) NECESSITY FOR COLLECTION AND DISTRIBUTION OF INFORMATION

Within the limits of functional responsibility, Production Control in replacing personal control, must be the means of informing and authorising individuals in the discharge of that responsibility and placing in the possession of these individuals knowledge which will enable them to exercise control.

Production Control must, therefore, be the nerve centre of information relating to planned production from all sources and it must be able to segregate and analyse this information, assess its effect on planned production and re-direct such information into the necessary channels in order to set in motion any machinery or function which is effected thereby.

(d) SPECIFIC CONDITIONS.

To sum up, Production Control must satisfy the following conditions—

(i) It must be able to Plan according to requirements and capacity.

(ii) It must be able to dovetail the work which the plan embraces into the Machine and Operator capacities and keep them fully occupied.

(iii) It must be able to co-ordinate material and tool requirements so that these are available for machines to run.

(iv) It must place in the hands of responsible individuals all the information concerning production in its relation to the plan to enable them to carry out their part of it.

(v) It must be able to guide production once set in motion towards the completion of the plan, take account of variations therefrom and also deal with their effect on present and future production.

3. Machinery of Production Control.

By referring to the Chart it will be seen that Production Control has been defined and then split up into two sections. The first are those functions which are purely Production Control functions and the second are those functions which are related to Production Control via planning.

It will also be noticed that the main function of Production Control has been laid down as Planning and the remarks in Section 2 will show clearly why this has been done—simply because Production Control of necessity implies Planning.

(a) RELATEDNESS OF FUNCTIONS WHICH ARE NOT PURELY PRODUCTION CONTROL.

The functions which are not purely Production Control are, of course related thereto in varying degrees. Moreover they fall under three main headings as follows :—

(1) Processing and Production Component.

(2) Engineering Component.

(3) Financial Component.

No attempt has been made to divide the functions or components of the above three divisions for it is considered unnecessary at this stage. Moreover, their relatedness to Production Control, or more correctly, that part of any one of the three which is Production Control, will be determined up to a point by divisions of responsibility.

The manner in which the Accountant builds up his costs is not necessarily the concern of Production Control, but the manner in which the costs are used for reflecting variation from plan is an important control element.

The method of Purchasing is not the concern of Production Control, but it is a responsibility of Production Control to see that information to enable purchase is in the hands of those responsible for this function and to enable a knowledge that this responsibility is being carried out in accordance with the plan of production.

The fact that jigs, tools, and fixtures are designed for a process is of no interest to Production Control in the technical sense. Production Control will discharge its responsibility so long as it collates all the information relating thereto in order that jigs, tools and fixtures will be available at the point of process when they are required.

Further to this, however, the responsibility of Production Control may not extend to the accuracy of the engineering information being used. This will be determined by the division of responsibility established between the functions of a particular industrial organisation.

Of course, in practice, Production Control in organising the supply of information of any of the above or other responsibilities will determine the amount, form, and type of information required and this will naturally cause an overstepping of its purely theoretical limits in these circumstances.

(b) PURELY PRODUCTION CONTROL FUNCTIONS.

By referring once more to the Chart it will be seen that the purely Production Control functions are five in number and in addition a definition has been given for each of them Planning is covered by the five definitions set out which are in reality the components of Production Control.

If these components are those by which control is expressed. they should provide the machinery to discharge the responsibility of Production Control. If they do, then the five definitions should provide an answer to the five requirements in Section 2.

Dealing with these requirements one by one we have the following—

(i) *Production Control must be able to plan according to requirements and capacity.*

The definition of Machine and Labour Utilisation provides for all the conditions which the factor of capacity requires, and as the requirements against the plan are known, this definition answers Condition (i).

(ii) *It must be able to dovetail the work which the plan embraces into the Machine and Operator capacities available and keep these capacities occupied.*

The definition of scheduling in conjunction with the definition of machine and labour utilisation is the main machinery by which this is embraced, though the other three components have influence in keeping the capacities occupied.

(iii) *It must be able to determine material and tool requirements so that these are available for machines to run.*

The definition of material control covers any conditions of material requirements, Tool requirements are catered for by the definitions of progress, scheduling and Machine and Labour Utilisation. It is, of course, obvious that tools may be only a matter of material control combined with progress when they are purchased. But when manufactured internally, they would in effect call for all the components of Production Control because tool production should comprise a plan of its own.

(iv) *It must be able to place in the hands of the responsible individuals all the information covering production requirements in their relation to the plan to enable them to carry out their part of it.*

The definition of Manufacturing Orders and Schedules combined satisfy every requirement of this necessity.

(v) *It must be able to guide production once set in motion towards the completion of the plan, take account of variations therefrom and also deal with their effect on present and future production.*

This responsibility is discharged mainly by the progress component and the definition of progress has been made sufficiently general to suit this. It is quite possible that variations in the plan will be reflected through channels other than progress, e.g. They might, as indicated earlier, arise from cost information. Material control might signal variations to the plan, or variations in machine efficiency may be the first indication that the plan is not being realised.

Certainly all the components of planning will be operative in the satisfaction of most of the five requirements outlined above, though certain of them are *principally* operative and this is the reason they have been quoted in this manner.

(c) Is Planning "Production Control"?

The answer is that Planning is the major function of "Production Control" but that other elements outside Planning must function via the Planning machinery before Production Control is really operative. These are the necessary components mentioned earlier which belong to the other industrial functions.

It will also be noticed that there has been continual reference to the functions and components and any mention of departments has been avoided. This is deliberate, for we are not interested in divisions of responsibility expressed departmentally, but in the fundamentals of Production Control. Obviously, division of responsibility along the same lines as functional and component segregation is at all times desirable, but not always possible and is a further issue which will be examined at a later date.

4. The Scope and Future of Production Control.

One of the functions of Production Control is to be able to examine the history of what has taken place in order to assess correctly the trend of events in the future and this process will be used in attempting to forecast the scope and future of Production Control.

(a) Production Control has its Roots in Necessity.

We have seen that Production Control has not reached its present stage because of the researches of individuals who consider that the present conception of control is necessary. Rather, it is the necessity of conscious control which industrial growth demands which has *driven* individuals into consideration of the subject. Production Control has its roots in necessity and this is proved by an examination of the growth of control which must follow increasing technical speciality and industrial complexity.

(b) Growth of Production Control Inevitable.

The importance of Production Control will depend entirely upon whether speciality will increase and production become more com-

plex and the scope of Production Control will attain even greater significance as the speciality of co-ordinating speciality; furthermore, and as already pointed out, Production Control is only a part of management science and therefore, its future is also linked thereto. Exactly the same arguments apply to management however for management is nothing but pre-meditated co-ordination of productive resources in a more general sense than Production Control

Technical speciality proceeds at such a rate that technicians can hardly keep pace with it and the present war is an example of the increasing complexity of industrial processes. In fact, the one cannot proceed without the other, and furthermore, the one makes the other inevitable.

(c) Necessity for Evidence.

So important is this question of setting Production Control in its proper perspective however, that it is considered necessary to prove by our examinations of the past that the above statements hold good.

(d) Historical Factors.

All processes of organisation are, of course, related and an attempt will, therefore, be made first to show how in the widest sense organisation will grow and how this will in turn affect the more detailed subject under discussion.

In the last fifty years the growing need for the organisation of international and national commerce has reflected itself in Combines, Trusts, Cartels, Joint Stock Companies, Quotas, Tariffs, Subsidies, etc. It became obvious from the trend of world markets in the ten years before the war that there were factors beginning to operate which to the thinking industrialist were highly important.

(e) Significance of International Organisation in the past Ten Years.

From 1931 onwards we entered a period charged with significance for the industrialist, for there was a gradual but increasingly rapid departure from previously accepted doctrines of the free interplay and movement of trade to the extent that implied a recognition of International Organisation

Increasing use of tarriffs, quotas and subsidies together with the establishment of Exchange Control and clearing agreements, and in Britain the setting up of the Exchange Equalization account were all moves which though previously intended to deal with specified circumstances and not conceived within a frame work of International organisation (often in fact they were entirely National in their immediate purpose) were the first real moves towards a recognition of this principle.

In the different countries the controls imposed a greater or lesser degree of freedom to the industrialist by the width of the differentials which in total they gave rise to.

In Germany Japan, and Russia the need for control was carried much further than in any of the democracies and there is no doubt that the evidence we have before us (irrespective of political considerations) shows that their productive machinery as a result of their organised economy placed us at so serious a disadvantage that we have had to adopt much of their method to enable us to catch up with them.

(f) Irrelevance of Political Motives.

The political motive which dominated Germany and Japan to desire to forge ahead with production of armaments is beside the point. What is important for us is that in order to acheive the maximum productivity from the resources at their disposal they recognised and put into operation the principle of organisation.

(g) Production Control Essential to Maximum Productivity in War Time.

Now that we are in the midst of war we in turn recognise that maximum productivity can only be achieved by the greatest possible degree of co-ordination to the factors of production and this in turn means that for the war, at least, Production Control as one of the means of co-ordinating capacity in accordance with a plan of production must be supported and used as widely as possible One of the reasons why there is so much controversy about Production Control is that the necessity for it is so great and our knowledge of it so small.

(h) Maximum Production Essential in Peace-Time.

But what of Production Control after the war? Will it still be one of the dominating factors in the co-ordination of productive resources or will the need to co-ordinate productive resources fall back once more to the standards of necessity with which we were familiar before hostilities broke out?

We have only to read our papers, examine the basis of the British economy, listen to our politicians, industrialists, economists and statesmen to realise that, though the control which is at present imposed will be eased, the days when Britain was Industrially Supreme will not return unless our efficiency can be increased to its previous relative level.

Production Control, therefore, is bound to play an ever increasing role in the maximum utilisation of capacity and in the co-ordination of technical and industrial processes.

5. Who is the Man for Production Control ?

(a) Divisions of Responsibility.

To enable us to decide who is the person best suited to the position of responsibility in Production Control we must say what responsibility Production Control carries. Unfortunate divisions of responsibility are not always in agreement with the functional lines, but we see that Production Control is responsible for Planning and its five sub-divisions. Also for the manner in which information from other functions which are not Production Control in their entirety but only in a limited sense, i.e., in the amount of information which they prepare which is used by the purely productive control function.

It could be argued that the person responsible for Production Control in a factory that is not operating efficiently may not be responsible for its inefficient operation, but he will be responsible for bringing this fact to the notice of those who are. So ultimately the most important fact which must be considered in giving a general guide on the suitability of persons for Production Control is that it is mainly concerned with the organisation of information towards certain definite ends.

(b) Ability for Organisation the Primary Factor.

It follows that the first qualification in nominating Production Control executives must be the ability to organise in this specific field and this means that his organising ability must be backed by sufficient clerical experience for him to appreciate the difficulties of reflecting physical movement in a clerical manner.

The second factor of importance is that he should also be able to appreciate the value of the information he is concerned in organising and in this connection it will be obvious that his most important information will be from engineering services. Therefore, an engineer who possesses organising and clerical combined with engineering experience, would be the best type. But it must be remembered that engineering experience though absolutely essential in a certain degree, is the secondary factor. Of two men, one with first class engineering ability and little experience of organisation of this sort, and the other with first class organising ability and experience and less engineering experience, the choice must be with the latter.

(c) Predominance of Engineering Qualifications.

There are also other factors to consider, for the information, though predominately engineering, will include financial, estimating and purchasing data and so it is desirable that some experience on these lines should be included. These, however are minor factors and, though desirable, are not essential.

Generally today, responsibility for Production Control is vested in an engineering specialist. The practice followed will vary, but mainly the Engineering Service and the Production Control functions are not divided and are merged into one responsibility. This has advantages, but it also carries the disadvantage that the engineering function assumes primary place and therefore it often happens that as responsibility is vested in a person whose main qualification is in the engineering field, the Production Control function becomes subordinate.

(d) NECESSITY FOR TRAINING EXECUTIVES TO PROVIDE IDEAL COMBINATION.

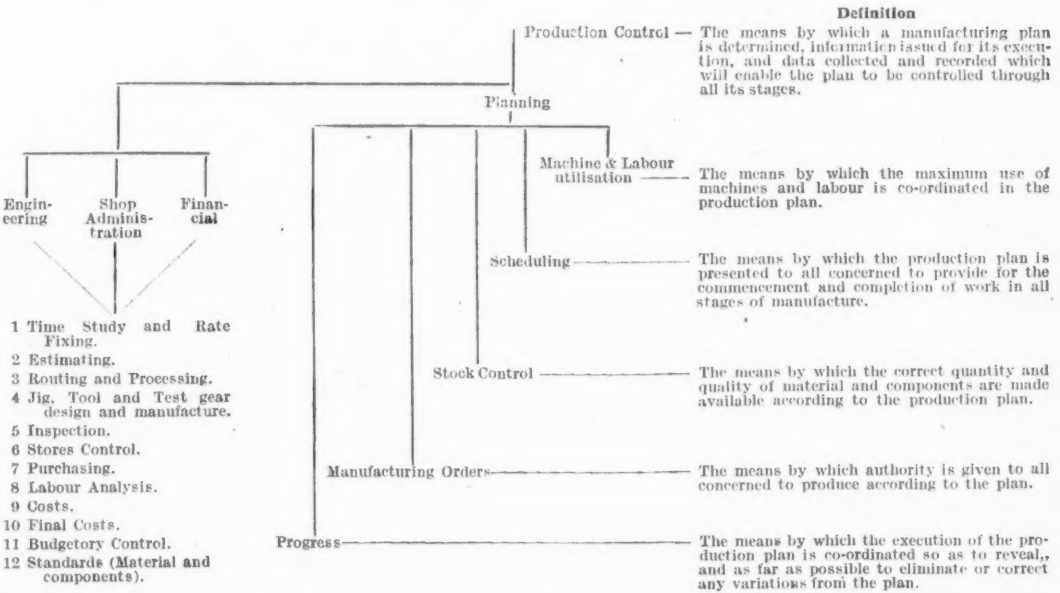
Provded a man can be found with the combination of Engineering and Organising experience there is everything to recommend the merging of Engineering and Production Control responsibility, but unfortunately, there is a dearth of organising ability in this country today and it is therefore recommended that the two functions are considered as such and controlled by separate executives.

Looking into the future, the need for the men with specialised Production Control experience and training is bound to increase and it may be that by proper training and educational methods we can produce men with the two most desireable elements of organising and engineering experience who will be able to fill this now growing need.

(e) PRESENT LIMITED CHOICE.

Until then we must press forward with Production Control and draw the men for it from whatever source presents itself, for it is on this science that the future of industry will be largely dependent.

APPENDIX. Chart Prepared by the Production Control Sub-Committee of the Institution


Definition
Production Control — The means by which a manufacturing plan is determined, information issued for its execution, and data collected and recorded which will enable the plan to be controlled through all its stages.
Planning
Machine & Labour utilisation — The means by which the maximum use of machines and labour is co-ordinated in the production plan.
Scheduling — The means by which the production plan is presented to all concerned to provide for the commencement and completion of work in all stages of manufacture.
Stock Control — The means by which the correct quantity and quality of material and components are made available according to the production plan.
Manufacturing Orders — The means by which authority is given to all concerned to produce according to the plan.
Progress — The means by which the execution of the production plan is co-ordinated so as to reveal, and as far as possible to eliminate or correct any variations from the plan.
Engineering
Shop Administration
Financial
1 Time Study and Rate Fixing.
2 Estimating.
3 Routing and Processing.
4 Jig, Tool and Test gear design and manufacture.
5 Inspection.
6 Stores Control.
7 Purchasing.
8 Labour Analysis.
9 Costs.
10 Final Costs.
11 Budgetory Control.
12 Standards (Material and components).

THE INSTITUTION OF PRODUCTION ENGINEERS

36, Portman Square, London, W.1

PUBLICATIONS OF THE RESEARCH DEPARTMENT

February, 1942

REPORT ON SURFACE FINISH, price 15/7 post free*

Part II. ACCEPTANCE TEST CHARTS FOR MACHINE TOOLS, price 5/7 post free

Earlier Publications

ACCURACY IN MACHINE TOOLS: How to measure and maintain it, price 3/3 post free

Part I. ACCEPTANCE TEST CHARTS FOR MACHINE TOOLS, price 5/6 post free

Also the following reports which appeared in the Institution's *Journal*, copies 5/- each, post free

	Vol.	No.		
Cutting Tools	XVIII,	11	1939	February
Dial Gauge and Its Use	XVIII,	11	1939	November
Research on Surface Finish (Preliminary Report)	XIX,	3	1940	March
Substitute Materials	XIX,	7	1940	August
Modern Measuring Instruments and the Principles of their Design	XIX,	9	1940	September
The Rebuilding of Old Machine Tools for the Requirements of War	XIX,	10	1940	October
The Effect of Reversing Flat Leather Belts	XX,	5	1941	May
The Natural Sag of Test Mandrels and its Consideration in Checking Machine Tools	XX,	1	1941	January
The Influence of Warming-up on Capstan and Combination Turret Lathes	XX,	4	1941	April
Taps, Efficiency, and Correct Design	XX,	6	1941	June

*Price to Members only, 10/7

THE GRINDING WHEEL AND PRODUCTION

Paper presented to the Institution, North Eastern Section, by F. W. A. Vickery

THE call to-day is for more and more war equipment. This demand will be unceasing until hostilities are concluded. Under these circumstances the time will be best used in considering whether we are making the most efficient use of our materials and to indicate how this can be checked and adjusted. The wide treatment of developments in grinding including machine design and wheel manufacture and selection can well be left for a later date.

Since the war began it has been found necessary to work most factories 24 hours per day. New factories are coming into operation weekly and the requirements of grinding wheels has multiplied many times. Unfortunately it has not been possible to increase our wheel manufacture proportionately, and while there is no apparent shortage of materials the wheel factories are seriously overloaded.

To the credit of our wheel manufacturers it was possible to supply to normal delivery schedule until the early part of this year. The position has rapidly changed during the last few months and will probably get still worse. It is therefore necessary that grinding wheel users should make the best use of available stocks.

A further consideration makes it essential to use materials to the best advantage. Practically all abrasive grain is made in the electric furnace which is only a commercial proposition where cheap hydro-electric power is available. We are therefore dependent on America and Canada for our present supplies. These are, of course, exposed to all the dangers of the Atlantic crossing. Prior to the war supplies were available from Norway, France and Czecho-Slovakia, but these are now in enemy hands and doubtless being made full use of without any great risk in transit.

Abrasives.

The grinding wheel consists of abrasive grains tied together with bond. Only two artificial abrasives are in general use.

(1) *Silicon Carbide*: This is the product of fusion of sand and coke at a very high temperature.

Newcastle, November 21, 1941.

It is slightly harder than Alumina. It is also quite brittle and is most suitable for the grinding of materials of low tensile strength, *e.g.*, cast iron, chilled iron, brass, aluminium, copper, marble, cemented carbides, etc. It fractures easily with minimum wheel wear.

(2) *Alumina* : This is a product of the fusion of Bauxite (Aluminium ore) at a very high temperature. This abrasive can be treated in manufacture to give the required physical properties necessary in its application. It is generally used on materials of high tensile strength, *e.g.*, all classes of steel, annealed malleable iron, etc., where the high resistance of the work requires a high impact strength in the abrasive.

Bond.

The grade hardness of a wheel is generally indicated by a letter of the alphabet. The universal scale of hardness follows the alphabet from ' G ' for very soft wheels to ' Z ' for very hard wheels in graduated steps.

The hardness is determined by the bond content, the higher content holding the grains more securely for economic wear on more severe grinding operations. A lower bond content releases the grain before they cease to cut when heat would be generated setting up cracks in sensitive wheels and cemented carbide tools.

Factors for Economical Use.

We will now consider how to use the wheel to its maximum capacity with economy of abrasive material. Please pass these suggestions to foremen or charge-hands concerned in your works.

It is not suggested that any of these points are entirely overlooked but a systematic check would result in an appreciable increase in efficiency in almost all grinding shops.

(1) *Wheel Speed.* The wheel speed should be kept as near as possible to the maximum operating speed recommended by the maker. This is usually marked on the blotters on the wheel. Wherever provision is made for changes of wheel speed at predetermined wheel sizes these changes should be insisted on. Speeds appreciably lower than recommended give a low rate of stock removal and are wasteful of abrasive.

Over speeding should be avoided as less external force is required to break the wheel due to the high internal stresses which are set up.

Most foundries are now installing High Speed Machines for dressing castings, etc., using wheels which run at 9,000 s.f.p.m. The rate of stock removal with these machines is two to three times faster than the low speed machines running at 6,000 s.f.p.m. The High Speed Machines are generally provided with three spindle

speeds so that the wheel can be speeded up as it wears down to specified diameters. This is not often taken advantage of and the machine allowed to run at low speed continuously. A 30 in. wheel running at 9,000 s.f.p.m. at 25 in. the speed has dropped to 7,500 s.f.p.m., and at 20 in. to 6,000 s.f.p.m. We would consider the grinding action at least one grade softer at 7,500 and two to three grades softer at 6,000 s.f.p.m. Unless these speed changes are made there is a distinct drop in rate of stock removal in metal and waste of abrasive material.

(2) Use coarsest grit size which will give a satisfactory finish. This will give the maximum rate of stock removal.

(3) *Dressing* (off-hand grinding). This is generally applied to hard wheels used in Foundries and off-hand tool grinding using a star shaped cutter. A light dressing at regular intervals will show the greatest economy. The rate of stock removal may drop from 10-lbs. per hour to 3-4 lbs. per hour with a dull wheel and much greater physical effort is required on the part of the operator.

(4) *Truing* (precision grinding). This is generally carried out with a diamond. A flat (dull) diamond closes the wheel face and may cause it to act one or two grades harder in grinding action. It is impossible to make a free cutting wheel face without a sharp diamond. When finishing with the diamond many operators continue to traverse across the wheel until the cut dies out. The object is to secure a better finish, but the effect is to close the wheel face and reduce the rate of cutting.

(5) *Hard Wheels.* If a wheel requires continual dressing or truing it is too hard and will show a low rate of stock removal. Wheel life will be short not due to wear but to dressing away. If only slightly on the hard side a faster diamond traverse will often prove sufficient to effect an improvement. If definitely too hard select one or two grades softer.

(6) *Off-hand Grinding.* There is a certain pressure for maximum rate of stock removal. Excess pressure only crowds the wheel, causing it to load and reduce the rate of cutting. In general, much faster cutting would be achieved with considerably less physical effort.

(7) *Wheel breakages.* The distance between the work rest and the wheel should not exceed $\frac{1}{8}$ in. Breakages occur through this not being reserved and the work jamming between the wheel and the rest.

(8) *Cylindrical Grinding.* Use faster traverse and lowest work speed for maximum rate of cutting with minimum wheel wear and power consumption.

The wider the wheel face, the faster traverse and slower the work speed and *vice versa*.

Many operators allow the final cut to die out to develop a good work finish. This glazes the wheel so that it is quite unsuitable for the following roughing operation unless trued with a diamond.

(9) *Grinding Cemented Carbides.* The carbides are nearly as hard as Silicon Carbide abrasive. This calls for soft grade wheels of open structure, allowing quick release of the abrasive grains, otherwise they cease to cut keenly and generate considerable heat with danger of cracking the tools.

When grinding high-speed steel tools the loss of weight of wheel to metal removed is in the ratio 1 : 5. With Carbide tools the ratio is reversed, viz : 5 : 1. If very heavy hand pressure is used this ratio may go to 10 : 1 so that it is important that operators are properly instructed in this direction.

Badly chipped tools should be roughed out on the periphery of a wheel say 20 in. diameter, 2 or 3 in. wide. The rate of metal removal by peripheral grinding is approximately 10 times the rate when grinding on the side of a recessed wheel, with much reduced wheel wear.

If seriously applied these suggestions will show increased output for minimum wheel cost. These conditions will be found most desirable when we return to normal commercial manufacture.

Some of the problems presented to our Engineering Department are very amusing and very interesting, including application of abrasive to peeling potatoes and radishes. We recently had an enquiry from Australia enclosing a piece of felt hat with a request "Could we recommend a wheel which would make it look like velour ?" Silicon Carbide met the requirements in all cases.

A more complicated problem was received from South Africa, and read as follows :—

June 25, 1941.

"I have a Sales Engineering question to ask, and to discuss with the Technical Department concerned.

I had a problem from one of my customers, who is having to build a pillar of concrete at the Pretoria Zoo, which will be required for scratching the back of the elephant.

After looking through Norton's Information and Selection booklet, and other text books, it is difficult for me to decide on the correct specification to supply for this job.

As it was difficult to classify the type of material to be ground, I did not know if an elephant's hide was of High Tensile strength or Low Tensile strength, so after studying the matter for many days, I decided to supply an assortment of both Crystolon and Alundum.

The Grit and Grade of the Abrasive supplied was also a difficult question, and I then decided to supply both coarse and soft, so that the elephant would not object to too hard a specification being supplied.

This is a most amusing job. The concrete column that they are supplying has to be strong, and bits of abrasive wheel have to stick out all over the surface.

It appears that elephants in their wild state get a skin disease and in the forest they are able to get rid of this, by rubbing themselves against the rough bark of a tree.

In the Zoo, they still get the skin disease, but they have not yet found anything suitable for them to rub themselves against, and so get rid of this disease.

In discussing this matter with Sales Engineering, I hope you will give the matter very careful consideration, as this job might become quite an important one in the many Zoos throughout the world.

The abrasive that we supplied, were bits of broken grinding wheels, etc., that we had accumulated, and were presented free of charge to the elephants in the Pretoria Zoo.

I will be interested to have a reply from you, and to have your further recommendation."

Discussion

MR. BOWEN (Chairman): We have a problem in connection with a diesel engine nickel steel rod. We grind the small end and the big end. Our foreman has instructed the operator that to get a perfect circle he roughs out dry, and then dresses his wheel and uses a coolant say to remove the last 0.002 in. This wheel is dressed every time on every small end and every big end. I would like to know whether you consider that is the correct method.

MR. VICKERY: I cannot quite see the object in grinding dry to the last 0.002 in. The function of a coolant is to prevent the generation of heat which produces distortion.

MR. BOWEN: I would like to know whether you consider he would get a truer hole by grinding by that method, and is it necessary to dress the wheel for each piece.

MR. VICKERY: No. The selected method may be due to some local conditions which the foreman has overcome by trial in this way. It is not necessary to true the wheel for each piece if it is standing up to its work and not glazing.

MR. BUCHANAN: I would like to know why Bakelite bonded wheels are not used more in precision grinding.

MR. VICKERY: They have been tried. Bakelite bonded wheels, when they were first introduced were introduced in the snagging field, and really I think Shellac wheels are preferable to Bakelite

where finish is demanded, but I can tell you rather an interesting point with regard to thread grinding. As you probably know, some of the American machines are using vitrified wheels, specified to run at about 8,000 feet per minute. Normally in this country our safety regulations do not allow us to run over 6,000 feet per minute. In the States they run at 6,500 normally, but on thread grinding they are running at 8,000 feet per minute because they found that the wheel keeps its form better, that it cuts cooler and gives a more consistent and accurate result. Bakelite has been tried for safety but it was found that Bakelite had sufficient resiliency to follow the lead error. It did not correct, it followed it. The reason is that it is not so rigid. The Vitrified wheel is rigid. Bakelite has really not yet been fully investigated.

MR. BUCHANAN : It does not need to be so rigid.

MR. VICKERY : It is very doubtful whether, on precision grinding, you would be allowed to run a wheel at that speed. You are thinking of general precision grinding. It might call for new machines, and the machine would have to be built round the high speed, and that is probably why it has not yet been developed. The existing machines do not show any advantage. There is no doubt investigations will be carried out.

MR. SWALLOW : Would a Bakelite wheel have more tendency to burn ?

MR. VICKERY : No. It is just as open in structure as Vitrified. Burning is more a question of grade selection. There is more trouble from poor diamond dressing than anything else.

MR. PERKS : I was not quite clear about the reference to sparking-out, etc. Were you referring to the trueing of the wheel, or the wheel on the job ? With the Plain Grinders, using the in-feed method, the machine is tripped and automatically feeds in and sparks out.

MR. VICKERY : I was referring to that type of operation where there is a long traverse. The operator dresses his wheel for roughing. He will run the work back and forward until the wheel sparks out, when it is generally glazed for the following roughing operation. A really good ground job is not a polished finish. Many inspectors will only pass work which has a polished finish but it is not usually so accurate as a ground finish.

MR. STEPHENSON : Has Mr. Vickery any figures regarding the cubic inches of metal removed per cubic inch of wheel wear when surface grinding Cast Iron ?

MR. VICKERY : I have not any actual figures. It largely depends on the specification you have selected for the work. That could only be determined by experiment on the particular work. There are widely different areas of contact, and you can vary the grit size, grade and the structure of the segment.

MR. STEPHENSON : Striking an average, what cubic inches of metal can be removed ?

MR. VICKERY : About 15 cubic inches of metal removed per cubic inch of wheel loss would represent an average economical ratio.

MR. PERKS : Have you found that female labour on grinding machines has produced excessive wear of wheels ?

MR. VICKERY : I think so, in the initial stages, because they do not really appreciate the forces that are set up. I should say in some cases they approached the danger mark—probably they have passed it, but we have not heard about it. After a while there —is no doubt that female labour will adapt itself very successfully, because it is an operation where the question of "feel" can be developed to a very high degree.

MR. BAKER : Are thread grinding machines with vitrified wheels permitted to be used in this country to run at high speed ?

MR. VICKERY : Yes, but the wheels must be specially overspeed tested before they leave the works, and will be run at 50% over their normal working speed, which gives the necessary safety factor.

The Jung Surface Grinder runs at a higher spindle speed than the Brown & Sharpe, and we have to test wheels for this machine at the approximate speeds. Wheels for this machine have to be specially marked.

MR. BAKER : Is it possible to true a wheel for precision grinding by a mechanical truer, or must you always use a diamond ?

MR. VICKERY : There is a mechanical dresser in a disc form with corrugated edge, but I have not found any application where it was successful. That type of dresser has the effect of closing the wheel face. I have seen it tried in two or three places with the same result.

MR. COPP : Arising out of your remarks for studying economy, is it a fact that if you true a wheel up, truing it by hand traverse, you get a better result for lasting effect, *i.e.*, grinds more pieces between truings ?

MR. VICKERY : Provided he is an expert operator doing the hand-truing, there is probably very little to choose. An experienced operator, and a good grinder, may do it better by hand. There will be something about his way of traversing the diamond over the wheel different from a mechanical pull.

MR. PERKS : Has nothing been developed from the machine manufacturers' point of view for varying the speed of the wheel to maintain its efficiency as it wears down ?

MR. VICKERY : On the latest high-speed machines in foundries a two or three step spindle drive is provided so that really a 30 in.

wheel can be equally as effective at 25 in. and 20 in. if the speed changes are used. Otherwise, probably half the wheel at least is run at half its efficiency.

It is rare on precision grinding machines to find variable wheel speeds, and a wheel too hard should be rejected and a new selection made in a softer grade.

MR. RICKERBY: Is the modern grinding wheel so critical as regards speed?

MR. VICKERY: No, but there are definite limitations in speed, and those limitations are marked on the blotters supplied with the wheel.

What we usually do is to give the test speed, and we also state the maximum operating speed, and that should not be exceeded.

At speeds less than the maximum operating recommended, the grinding action is softer and each 1,000 s.f.p.m. down is approximately equal to one grade softer in grinding action.

MR. BOWEN (Chairman): I want to thank you for your attendance tonight, and I hope a lot more of you will turn up on the 12th December to hear Mr. Chilton.

I would like to pass a very hearty vote of thanks to Mr. Holmes and Mr. Vickery for the very able manner in which they have given their lectures, and I would like Mr. Swallow to second this.

MR. SWALLOW: I am very pleased to second that. I think they have been very interesting papers, and I think we have had a good night.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research)

NOTE.—*The addresses of the publications referred to in these Abstracts may be obtained on application to the Research Department, Loughborough College, Loughborough.*

ACCOUNTING, ADMINISTRATION.

The Student of Cost Accounting, by E. Emmerson. (*The Cost Accoutant, April, June, 1942, Vol. 21, No. 8, p. 297*).

Need for technical knowledge. Essential qualifications for a cost accountant. Practical approach to problems. Method of applying principles. Need for wide and varied experience. The human element. Practical application. "Why?" "Where?" "When?" "How?".

COOLANT, LUBRICANT.

Working with Cutting Fluids. (*The Machinist, July 4, 1942, Vol. 86, No. 12, p. 225, 3 figs*).

Types of cutting fluids: Air; aqueous solutions; soluble oils; straight cutting oils; mineral-lard oils; sulphurized oils; Action of cutting fluids: emulsions; Cutting oils when properly selected and applied reduce the built-up edge when machining tough metals, reduce temperature and chip pressure, limit tool erosion, and give an accurate cut with the least expenditure of power. Applications of cutting fluids. Oils for grinding. Fluids for carbide tools Reconditioning. Prevention of infection.

Cutting Tool Life and Cutting Fluids, by O. W. Boston. (*The Tool Engineer, U.S.A., May, 1942, Vol. XI, No. 5, p. 84, 16 figs.*).

Chip form and tool wear. Surface quality vs. speed. Surface quality vs. cutting fluids. Tool life vs. cutting fluids. Cutting-speed tool-life relationship.

EMPLOYEES, WORKMEN, APPRENTICES.

The Foreman's Balance Sheet, by Harrison R. Dunning. (*Personnel, May, 1942, Vol. 18, No. 6, p. 350*).

One of the most difficult tasks of management is to impress upon foremen and supervisors the importance of balanced supervision. Ratings for foreman's balance sheet: cleanliness, orderliness, safety, quality, costs, methods, machines, materials, policies, personnel; co-operation, grievances, leadership, inspiration, production.

Guns *and* Butter: The Paradox of Collective Dealing, by Egbert H. van Delden. (*Personnel, U.S.A.,*) (*May, 1942, Vol. 18, No. 6, p. 322*).

The author scrutinizes Union contracts in the light of today's production needs, and finds that a good many provisions—most of them originally designed to spread employment—now operate to hamper the all-out war effort at every turn. In this frank analysis of a situation he points out

exactly how Union contract provisions have been putting the brakes on production, and indicates the steps that management must take to make sure that its operating efficiency is not curtailed by Union regulations.

MACHINE ELEMENTS.

Special Ball Bearings, Roller Bearings and Ball Chains for Machine Tools. (*Machinery Lloyd, July 11, 1942, Vol. XIV, No. 14, p. 55, 10 figs.*).

Extra light, double row bearing with locating flanges. Bearings for heavy thrust loads. Wide ring bearings with locating flange. Precision type roller bearings for spindle mounting. Ball chain for machine tool ways. The principles of preloading.

Shorter Sleeve Bearings—III, by E. R. Summers. (*The Machinist, July 18, 1942, Vol. 86, No. 14, p. 88E, 5 figs.*).

Test results for a 2¾ in. by 2¾ in. bearing with spiral grooves over a load range from zero to 5,000 lb. at speeds from 600 rev. to 1,800 rev. per min. Practical considerations usually restrict the bearing pressures to less than 200 lb. per sq. in. Bearing with horizontal dead-end groove. Bearings for general-purpose and large direct-connected motors. Temperature rise in bearings. Effects of different lubricants. Limitations of split bearings. Bearings of different diameters. Sleeve bearings are well able to carry loads far beyond the usually accepted values, provided the bearings dimension are proportioned for correct distribution of load, the bearings are properly grooved, and there is an adequate supply of oil to the high pressure area.

MACHINING, MACHINE TOOLS.

How to Use Abrasive Cutting. (*The Machinist, July 11, 1942, Vol. 86, No. 13, p. 275, 7 figs.*) and,

Results from Abrasive Cutting, by H. G. Robinson. (*The Machinist, July 25, 1942, Vol. 86, No. 15, p. 332, 2 figs.*).

How to get the best results from abrasive cutting wheels and a summary of differences between wet and dry methods. Non-oscillating type machine for bar type materials up to 2 in. diameter. Oscillating machine—for bar type materials to 6 in. solid. A table gives: diameter of material in inches; material area sq. in.; new wheel diameter in in.; wheel thickness in in.; approx. number of cuts per wheel; time per cut in seconds.

MANUFACTURING METHODS.

Manufacturing the Rolls-Royce Merlin XX. by J. A. Oates. (*Aircraft Production, August, 1942, Vol. IV., No. 46, p. 486, 38 figs.*).

The machining of the crankcases and cylinder blocks cast in the foundry to be described later. In the erection department a most efficient line system has been adopted whereby the unit sub-assembly lines feed into the main track. A similar system, incorporating elevated rail tracks with turntables leading to sidings, is used also for sub-assembly purposes.

MATERIALS, MATERIAL TESTING.

Cast Iron. (*Automobile Engineer, June, 1942, Vol. XXXII, No. 424, p. 237, 3 figs.*).

Future developments and possibilities in the automobile industries. Unsuitable units. (1) Chromidium cylinder blocks, heads and crankcases. (2) Piston, cylinder liner, valve seat and valve guide in nickel chromium cast

iron. (3) Two-throw nickel-chromium-molybdenum cast-iron crankshaft cast in pairs. Austenitic irons. Chromium. Molybdenum. Effects of copper.

Bearing Metals for the New Wartime Conditions. (*Automotive and Aviation Ind., April 15, 1942, Vol. 86, No. 8, p. 39*).

This company has developed a new PB-base bearing alloy containing 12.5% Sb, 3% As, 0.75% Sn. Brinell hardness and fatigue strength are claimed to be favourable and the alloy is stated to have good handling qualities in the molten state.

(*Supplied by the British Non-Ferrous Metals Research Association*).

Problems Involved in Changing from Aluminium to Cast Iron Pistons, by W. S. James. (*S.A.E. Advance Copy, 1942, B.N.F. Serial 24,900*).

Seven United States car manufacturers anonymously give their experience of the change-over. Much useful detail of all kinds.

(*Supplied by the British Non-Ferrous Metals Research Association*).

Economy in Tin by using High Lead Solders. (*Sheet Metal Industries, August, 1942, Vol. 16, No. 184, p. 1150, 1 fig.*).

Next to tin and terne plate, solder has been the largest user of tin. Of some 90,000 long tons of tin used in 1937, about 40,000 tons went into tin-plate and terne-plate, with 20,000 tons into solder, of which some 12,000 tons was new metal and 8,000 reclaimed or secondary tin. In 1941, when 48,700 tons of tin went into tin-plate, solder manufacture consumed 18,420 tons of new tin (America). Tin elimination. Cadmium alloy. Taking all things into consideration, use of the straight binary lead-silver solder appears to be the best way of eliminating tin in solders. Promoting spreading. Controlling spreading. Tin pickup. It appears feasible to produce soldered joints on hot-dipped tin-plate without any tin in the solder. Electrolytic tin-plate. Dip soldering.

Tin Economy in Plain Bearings, by P. T. Holligan. (*Mechanical World July 17, 1942, Vol. CXII, No. 2898, p. 49, 1 fig.*).

Practical notes to help in carrying out the Ministry of Supply recommendations. Method of approach. White metals. Tin and lead base white metals. Intermediate alloys. Unorthodox lead-base alloys. Composition and reduction of thickness. Composition in relation to design. Solid die-cast bearings. Safeguarding clauses. White metal scrap. Reduction of thickness of linings. Dovetailing. Bearing bronzes. White metal lined bearings and bushes. Unlined bearings and bushes.

Non-Destructive Testing of Metals and Alloys, by J. W. Donaldson. (*Metal Treatment, Spring 1942, Vol. 8, p. 2*).

Review of the essential characteristics and scope of application of the various types of test which may be used to examine particular properties of a material without impairing its service usefulness. The various methods of examination are classified into accoustic, optical, magnetic, electrical, radiographic and static or hydrostatic tests. Reference is also made to indentation hardness tests and determination of damping capacity, as ranking among non-destructive methods.

(*Supplied by the Nickel Bulletin*).

Structure and Fatigue Strength of Al-Cu-Mg Wrought Alloys (DIN 1713) with relatively large Mn and Mg content, by W. Bungardt. (*L.F.F., Germany, Vol. 19, No. 5, May 30, 1942, p. 174*).

In German aircraft construction, considerable use is made of Al-Cu-Mg wrought alloys (DIN specification 1713) with relatively large Mn and Mg content. The % composition of these alloys is as follows : Cu 4-4.5, Mg 1-1.3, Mn 1-1.3, Fe .5, Si .7, Al rest. In the great majority of cases, pressed or rolled material of this alloy has a satisfactory uniform structure, the excess Mn-Fe aluminide crystals being only of small dimensions and arranged linearly. Under certain melting and solidification conditions which have not yet been completely elucidated, it may happen however that the aluminide crystals in the original casting increase over a hundredfold in size and on account of their brittle nature introduce zones of weakness during the subsequent cold working. The author has carried out tests on wrought alloys subjected to this defect and whilst the ultimate tensile, yield point, extension and notch sensitivity are not appreciably affected, the bending fatigue strength of a smooth cylinder is reduced by about 15% below the standard value. In the case of a notched cylinder the effect is however very small. The large crystals evidently function as internal notches, the effect of which is however still small compared with the weakening effect of an external notch.

(*Communicated by D.S.R., Ministry of Aircraft Production*).

MEASURING METHODS.

Optics applied to machining operations, by D. L. Benton. (*The Tool Engineer, U.S.A., June 1942, Vol. XI, No. 6, p. 67, 23 figs.*).

The variable centre scope is a shop tool. To locate for boring hole exactly in diameter of bar. Placement of edge block. Angle plate aligned with table T-slots. Machine spindle aligned with edge of angle plate. Measuring die cavity.

PHYSICS.

The Damping Capacity of Engineering Materials. (*Mechanical World, July 17, 1942, Vol. CXII. No. 2898, p. 52, 3 figs.*).

Machine specially designed for investigation of damping capacity. Graphical records of the percentage damping per cycle of a number of materials at elevated temperatures.

METALLURGY OF IRON AND STEEL.

Design of Steel Casting, by H. Ocking, (*Stahl & Eisen (Germany), Vol. 43, No. 26, June 28, 1942, p. 841*).

The main difficulty in casting steel is the avoidance of blowholes due to trapped air. For this reason, horizontal surfaces in the mould must be avoided as far as possible and replaced by sloping or conical surfaces. The author demonstrates this on a series of pulleys and wheels which have been redesigned to allow the trapped air to escape before solidification. Some of these castings are of considerable diameter (18 feet) and provided with only very simple vertical ribbing. It is claimed that conical surfaces adapt themselves more readily to shrinkage during cooling than horizontal surfaces. This is of great importance, since steel castings undergo about 3 times the linear shrinkage of ordinary cast iron (2% against .7%) as a result, its conical casting is largely free of internal stresses. The machining of such surfaces can be carried out automatically in a simple manner and since blow holes are mainly confined to the central riser, excess material to be removed by machining can be restricted to the utmost.

(*Communicated by D.S.R., Ministry of Aircraft Production*).

PLASTIC MATERIAL.

Plastics in National Defence, by H. A. Frommelt. (*The Tool Engineer, U.S.A., June 1942, Vol. XI, No. 6, p. 55, 9 figs.*).

Are plastics an engineering material? How do they compare with metals in defence and peace-time applications? The research director of a leading milling machine company answers these questions. He also describes mold-making, speeds and feeds, and points to the Tool Engineer's future in the plastics field. Molding methods. Time, temperature, pressure. Tensile strength. Elasticity. Applications: A clutch body ring applicable to a machine tool. Automobile pump impeller. Ball bearing retainer rings. Plastic washing machine agitator, etc. Mold-making equipment. Plastic parts on airplanes.

Plastics in Aircraft Tooling. (*Aircraft Production, August 1942, Vol. IV, No. 46, p. 486, 15 figs.*).

Review of the development work carried out by the Lockheed and Vega companies in the United States. This research has resulted in the production of drill jigs made entirely from plastic material, with the exception of the guide bushes, and in the manufacture of forming dies capable of withstanding high unit pressures. A simplified technique has been developed for making these tools and large savings are claimed both in time and expense.

NEW METHODS FOR MECHANICAL TESTING OF PLASTICS.

New Methods for Mechanical Testing of Plastics, L. H. Callendar. (*British Plastics, Vol. 13, No. 155, April, 1942, p. 445*).

Impact testing to cross-section has been for a long time a need of engineers in many industries, to enable them to test materials in the state in which they are used, instead of relying on doubtful comparative values from specially made-up test pieces. A practical method is here described for impact tests to cross-section on electrical plastics. In the past the difficulty in the way of testing to cross-section has been mainly due to the general use of the excess swing pendulum method with Izod support. The errors of this method, namely, the "shearing and tearing" error and the "broken-half" error, are shown by a number of examples to be very large for plastics materials and quite sufficient to invalidate it for comparative brittleness testing of this class of materials.

Comparative brittleness testing to cross-section is shown by numerous results to be bound up with the following: (1) The use of the same radius of notch, namely, ½ mm., and the same depth of notch, namely, one-third of the thickness of the test-piece for all tests on pieces of any cross-section. (2) Charpy anvils adjusted to a distance apart equal to six times the thickness of the particular test-piece under test. (3) A minimum velocity of impact of 8 ft. (244 cm.) per second.

(4) The first definite crack or break must be taken as the end-point of the test. (5) The use of the guillotine or vertical drop-weight type of machine is also advantageous for this purpose; photographs of a recommended design of machine are given.

Among other matters touched on is the importance of plastic yield temperature and controlled humidity in relation to impact testing.

In the appendices photographs are given of a new simple machine for plastic yield temperature, and also the interesting theoretical question of the uncertain range is gone into at some length.

(*Communicated by D.S.R., Ministry of Aircraft Production*).

PSYCHOLOGICAL INVESTIGATION.

Women and Hours of Work in Industry Today. (*Labour Management, July, 1942, p. 89*).

The supply of labour. Fatigue and environment. Experience in light engineering. Adoption of two-shift system.

SMALL TOOLS.

Boring Bars, Pilots, Special Tools, by John G. Jergens. (*The Machinist, July 11, 1942, Vol. 86, No. 13, p. 280, 15 figs.*).

A varied group of 15 tools and holders is shown in the drawings.

Inserted-tooth Circular Metal Saws. (*The Machinist, Reference Book Sheet, July 4, 1942, Vol. 86, No. 12, p. 245, 5 figs.*).

How to obtain greater efficiency and make teeth last longer against : tooth breakage ; premature wear ; cutting out of line ; feed and speeds. Circular saws for cutting metal.

SURFACE, SURFACE TREATMENT.

The Formation and Evaluation of Zinc Coatings. (*Sheet Metal Industries, August, 1942, Vol. 16, No. 184, p. 1127, 4 figs.*).

The hot-dipping process. Cleaning. Fluxing. Floating it on the surface of the bath. Cross-sectional view of galvanising kettle. The galvanising process. Method of firing. Purity of zinc. A press type of corrugating machine.

Rust-proofing of Ferrous Metals, by H. Silman. (*Sheet Metal Industries, August, 1942, Vol. 16, No. 184, p. 1173, 3 figs.*).

Ferrous metals are often covered with scale, or rust, which must be removed before the application of the finishing operation. Acid pickling. Types of lubricant. Effects of annealing. Electro-cleaning. Hot-tinning. Temperature control. The tinning of cast iron is difficult. Barrel tumbling or shot-blasting are satisfactory, followed by a light pickle in hydrochloric acid, which serves to remove the film of graphite. Coating with tin-lead alloys. Lead coatings. Hot galvanising. Electro-galvanised vs. hot-galvanisee coatings.

Buffing before Plating to Improve Rust Resistance, by F. G. Coffey, L. Borchert, and W. Pinner. (*Iron Age, April 16, 1942, Vol. 149, No. 16, p. 49*).

Tests made under regular commercial production conditions indicate that buffing the steel base before plating saves plating metal and racking time and produces a plated surface with increased rust resistance.

(*Supplied by the British Non-Ferrous Metals Research Association*).

WELDING, BRAZING, SOLDERING.

Modern Techniques for Deep Groove Welding, by J. Ashley Moss and A. R. Moss. (*Welding, July, 1942, Vol. X, No. 6, p. 128, 15 figs.*).

Instead of double vees or scarfs, requiring a large amount of weld filler connected with the disadvantage of distortion the "Mossprep" preparation was introduced. The "Mossprep" consists of performing one or both plate edges with one or more beadpreps. The beadpreps can be deposited at any position in the depth of the fusion face forming a gap similar to the standard single or double U. Definite sizes for the beadpreps cannot be given as their size and shape will depend upon several variable factors, such as the type and

make of electrode used, the position of the plate's edge, the desired width of gap and the ability of the welding operator, etc. However, three methods of forming them are discussed. The standard " Mossprep " : it can be stated that it has the well-known advantages of the U type of joint without requiring the costly and complicated machining operation to form the root faces, much less weld metal is also used and due to this fact greater welding speeds are possible.

Unionmelt Welding Dark Horse of Defence, by A. E. Rylander. (*The Tool Engineer, U.S.A., May, 1942, Vol. XI, No. 5, p. 73, 11 figs.*).

Unionmelt welding is an electric process using the heat generated by the passage of an electric current from an electrode to the work being welded. The end of the electrode is constantly covered by a highly resistant, conductive medium supplied as a special granulated material or welding composition. No visible arc. A figure shows the complete " Unionmelt " welding unit in the immediate size, mounted on a track. Entirely automatic. Compared to hand welding : a butt joint of two $\frac{1}{2}$ in. plates, each bevelled $\frac{3}{8}$ in. by 45°, making a section area of .14 in. take three passes and a rate of 3 in. per minute. It would take 100 mins. or 1-2/3 hrs. to weld a seam 100 ins. long. With Unionmelt at the rate of 13 ins. per minute the total time would be only 7.7 mins. for the weld.

A Comparative Study of the Processes of Bronze-welding and Brazing, by E. Christie. (*Sheet Metal Industries, August, 1942, Vol. 16, No. 184, p. 1199, 17 figs.*).

The field of bronze-welding operations extends from small-scale mechanical models to guns, tanks, aircraft, ships, railways, oil-wells and some of the largest engineering undertakings in the world, not only as a repair and maintenance medium, but also as a recognised and approved process for fabrication and construction. Flue stack elbow bronze welded repair showing broken sections and completed assembly. Motor casing repaired. Development. Comparison with other processes. Analysis. Bronze welding. Oxyacetylene flame adjustments. Diagrammatic sketch of bronze welding. Tool tipping diagram showing recess and method of setting the tip. Press gear wheel with broken teeth area prepared for bronze surfacing and building up operation. Bronze welding and brazing are akin to each other, there is a distinct difference at certain points. Both processes utilise copper zinc alloys as bonding metals. Both processes can be used to join similar or dissimilar metals together.

The Bronze-welding of Metals, by T. J. Palmer. (*Machinery, July 16, 1942, Vol. 61, No. 1553, p. 71, 8 figs.*).

A low-temperature technique. Similar and dissimilar metals joined by bronze-welding. Applications. Principles of bronze welding. Bronze-welding rods. Preparation of the work. Pre-heating. Tinning and base metal. Building up the joint. Appearance of the completed weld. After treatment. Heat effects.

The Bronze Welding of Cast Iron, by T. J. Palmer. (*Machinery, July 23, 1942, Vol. 61, No. 1554, p. 100, 7 figs.*).

Difficulties in bronze-welding cast iron. Method of preparing a fractured casting for bronze welding. A microphotograph of a bronze-welded joint between bronze and grey cast iron. Malleable irons. Joint between bronze and blackheart malleable iron. Section of a bronze-weld in a large iron casting.

A Milling Cutter Repaired by Welding. (*Machinery, July 30, 1942, Vol. 61 No. 1555, p. 136, 1 fig.*).

Owing to the arbor nut being insufficiently tightened, thus throwing extra strain on the keyway, a side and face cutter was completely split diametrically from periphery to bore. After locking the two halves together by means of a centre bolt and washers, both sides of the cutter were electrically welded. If the welding is not carried too near the cutter edge, no softening occurs. Seven welded cutters in some instances for gang milling have proved quite satisfactory.

WELFARE, SAFETY, ACCIDENTS.

Methods of Extinguishing Magnesium Fires and Incendiary Bombs Composed Mainly of Magnesium, by H. R. Brown, I. Hartmann, and H. P. Greenwald. (*U.S. Bur. Mines Circular Letter, March 23, 1942, p. 7, B.N.F. Serial 24,857*).

A general discussion of methods of controlling Mg fires, including hastening the combustion with water; partially sealing of the fire with materials that melt slightly, or completely with materials that soften and flow. Under partial sealing tests with numerous substances are described, under complete sealing there is an account of the use of hard coal pitch or petroleum asphalt. The use of the latter materials for extinguishing Mg fires and incendiary bombs is discussed in some detail.

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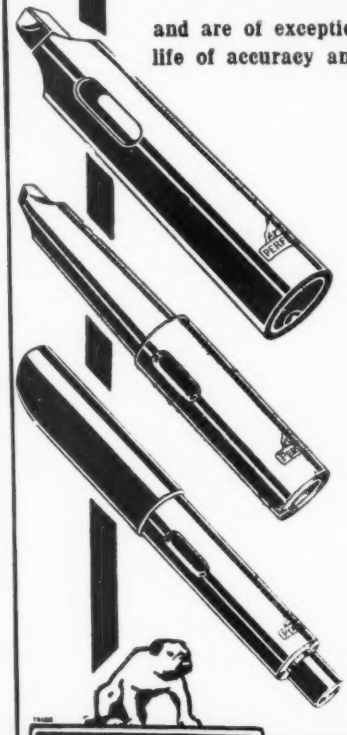

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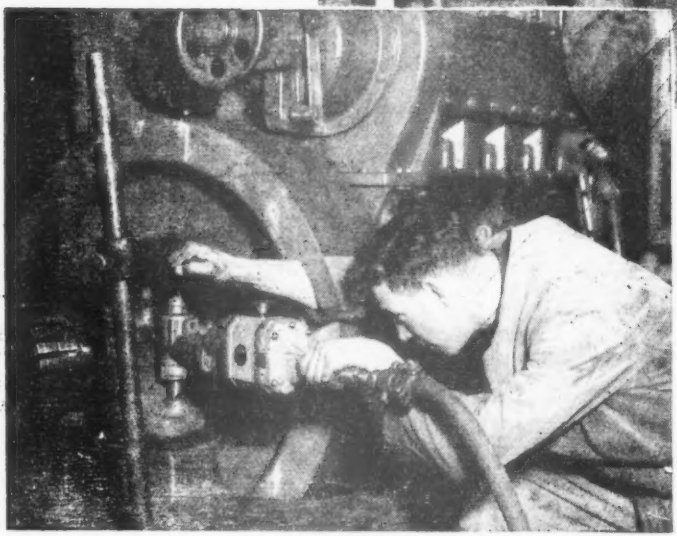

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Printed by Richard Bates, Limited, 9-13, Stockton Street, All Saints, Manchester 15.

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